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# The Competition of Tidal Mixing and Freshwater Forcing in Shaping the Outflow from Hudson Strait

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## LONG-TERM GOALS

A fresh plume, driven by the large riverine input into Hudson Bay, flows along the southern shore of Hudson Strait as a buoyant coastal current (Straneo and Saucier, 2008a and b). In the strait, the plume is subject to one of the largest semi-diurnal tides in the world and therefore to intense tidal mixing. The long-term goals of this project are to understand how these two competing stratification-inducing (the freshwater) and the stratification-destroying (the tidal mixing) interact, in Hudson Strait, to result in the observed coastal current and its variability. Next, we plan to generalize our results in the form of dynamical balances applicable to other coastal regions, estuaries and straits.

## OBJECTIVES

This is an intrinsically complex problem, given the feedback between the vertical stratification, the structure of the baroclinic tide, the bottom boundary layer, the mixing, and the strait dynamics. To address it, we propose to investigate specific relations between the stratification, tides, the local and remote forcing. First, we will investigate how the internal tide and the bottom boundary layer vary as a function of the mean flow and of its stratification. Then we will focus on the variability of the front and determine whether it can be attributed to local or remote wind/freshwater forcing or to the spring/neap tides (locally or upstream). In addition, we will use a numerical model (Regional Ocean Modeling System, ROMS) to investigate the impact of tidal forcing (and mixing) on a front similar to that observed.

## APPROACH

We will utilize mooring data from three successive year-long deployments in Hudson Strait to investigate the time-series and the different temporal and spatial scales over which the tides, the strait dynamics, the freshwater forcing and the wind act to shape the front, we believe their individual contribution can be diagnosed from the data. The data analysis will be complemented with a comparison with the existing theoretical models for boundary layers, gravity currents, strait dynamics

and mixing. We will also use modeling (ROMS) to investigate specific dynamical questions such as the response of the bottom layer to variable forcing. Specifically, we plan to

1. Estimate the structure, energy, and energy flux of both the barotropic and the internal tide. The relation and phase lag between the observed baroclinic tide and the forcing (barotropic tide) will be indicative of the location of the generation process and location.

2. We plan to investigate the structure of the boundary layer and estimate vertical viscosity. Our approach to this non-linear problem will be similar to that for estimating the parameters for the wind-driven time dependent Ekman spiral. Turbidity measurements will help interpret and verify our understanding of the mixing in the bottom boundary layer.

3. Investigate the high and low frequency variability in the freshwater outflow from Hudson Strait and its relation to river discharge, local and remote wind-forcing, strait dynamics and mixing processes and to the tidal forcing.

## WORK COMPLETED

The PIs are getting started on this work this fall.

## RESULTS

The PIs are getting started on this work this fall.

## IMPACT/APPLICATIONS

Freshwater discharge and strong tides are common features of many coastal areas and straits. We therefore plan to formulate our results in a generalized form so that they can be applicable to many coastal regions, estuaries and straits.

## RELATED PROJECTS

This project is complementary to the analysis of the interannual variability of the export from Hudson Strait funded by NSF-OCE (Straneo and Lentz, co-PIs) which includes a post-doc, Dave Sutherland. In addition, this project will benefit with an ongoing collaboration with Canadian colleagues from the University of Quebec who are working in the Hudson Bay, Hudson Strait region. In particular, we will be comparing our analysis with the results from a high-resolution regional model of the Hudson Bay System which includes tidal forcing as well as an a sea-ice model.

## REFERENCES

Straneo, Fiammetta and F. Saucier, 2008a: The outflow from Hudson Strait and its contribution to the Labrador Current. *Deep Sea Res. I, 55, 926-946.*

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